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(54) **PROTECTIVE SEAT LOAD FLOOR FOR HYBRID VEHICLES**

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B60K 1/04 (2019.01)
H01M 2/10 (2006.01)

(52) **U.S. Cl.**
CPC ***B60N 2/4263*** (2013.01); ***B60K 1/04*** (2013.01); ***H01M 2/1083*** (2013.01); *B60K 2001/0422* (2013.01); *B60K 2001/0433* (2013.01); *B60K 2001/0438* (2013.01)

(58) **Field of Classification Search**
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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,393,426	B2	3/2013	Takahashi et al.	
8,776,927	B2	7/2014	Akazawa et al.	
9,016,778	B2 *	4/2015	Hellman	A47C 4/54 297/188.09
9,321,338	B2	4/2016	Naruke	
9,506,255	B1 *	11/2016	Jones	E01C 9/086
10,232,788	B1 *	3/2019	Hagedorn	B60N 2/90
2002/0005649	A1 *	1/2002	Hofmann	B60R 7/043 296/37.15
2004/0100114	A1 *	5/2004	Rhodes	B60N 2/062 296/65.09
2004/0100116	A1 *	5/2004	Rhodes	B60N 2/062 296/66
2005/0056472	A1 *	3/2005	Smith	B60H 1/00278 180/68.1
2011/0262801	A1 *	10/2011	Schwab	B60K 1/04 429/163

(Continued)

FOREIGN PATENT DOCUMENTS

FR	2990386	A1	11/2013
FR	2997907	A1	5/2014
WO	WO 201276791	A1	6/2012

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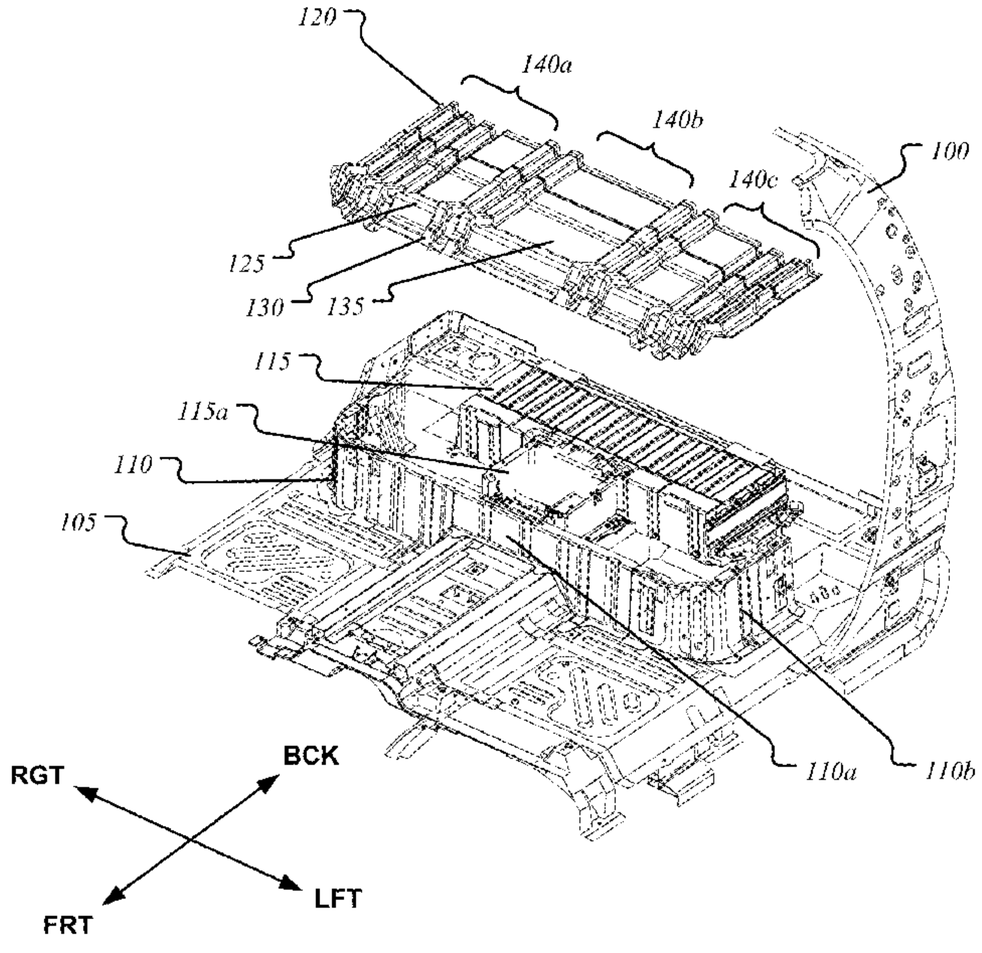
(57) **ABSTRACT**

A vehicle seating apparatus includes a structural tub and a protective seat load floor wherein the protective seat load floor includes an anti-submarining feature. The apparatus can also be disposed on top of the structural tub housing a battery for an electrified vehicle, wherein the seat load floor serves as the battery cover.

19 Claims, 5 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2014/0154460	A1*	6/2014	Preisler	B32B 5/18 428/116
2017/0267131	A1*	9/2017	Neighbors	B60N 2/3075
2018/0215318	A1*	8/2018	Abdel Majid	B60N 2/933

* cited by examiner

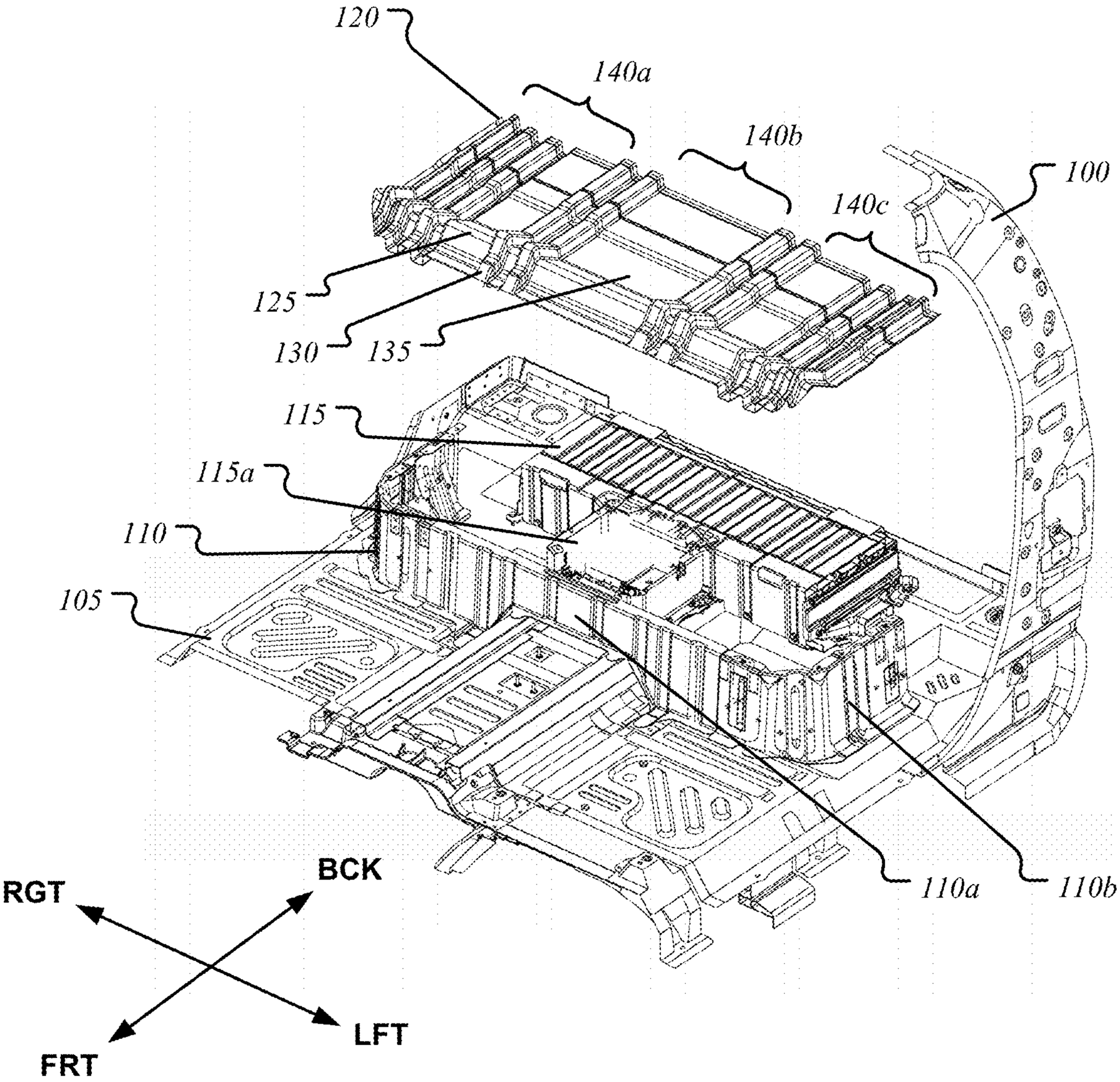

120
140a
140b
140c
100
125
130
135
115
115a
110
105
110a
110b
BCK
RGT
LFT
FRT

FIG. 1

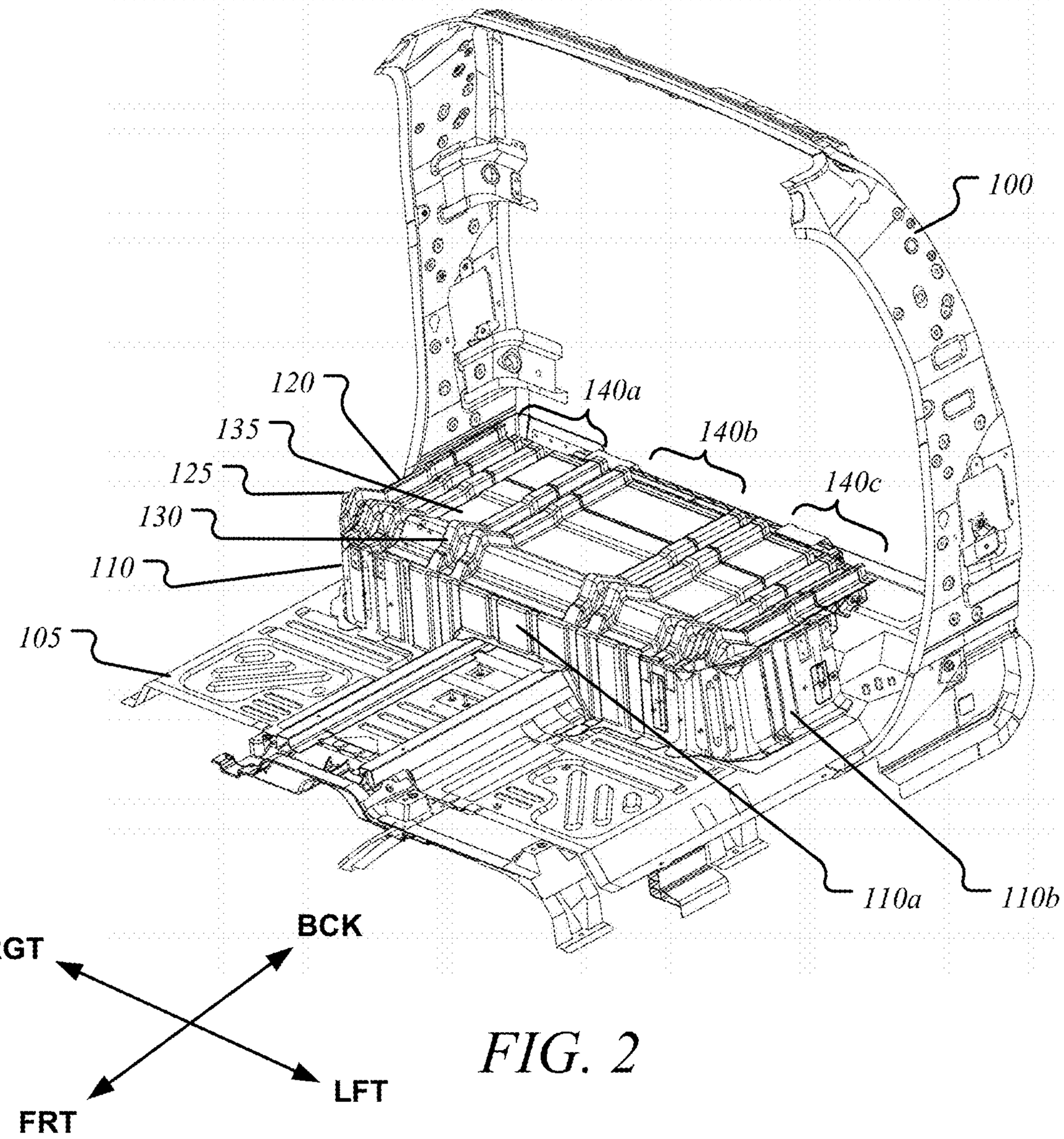

100
120
140a
135
140b
125
140c
130
110
105
110a
110b
BCK
RGT
LFT
FRT

FIG. 2

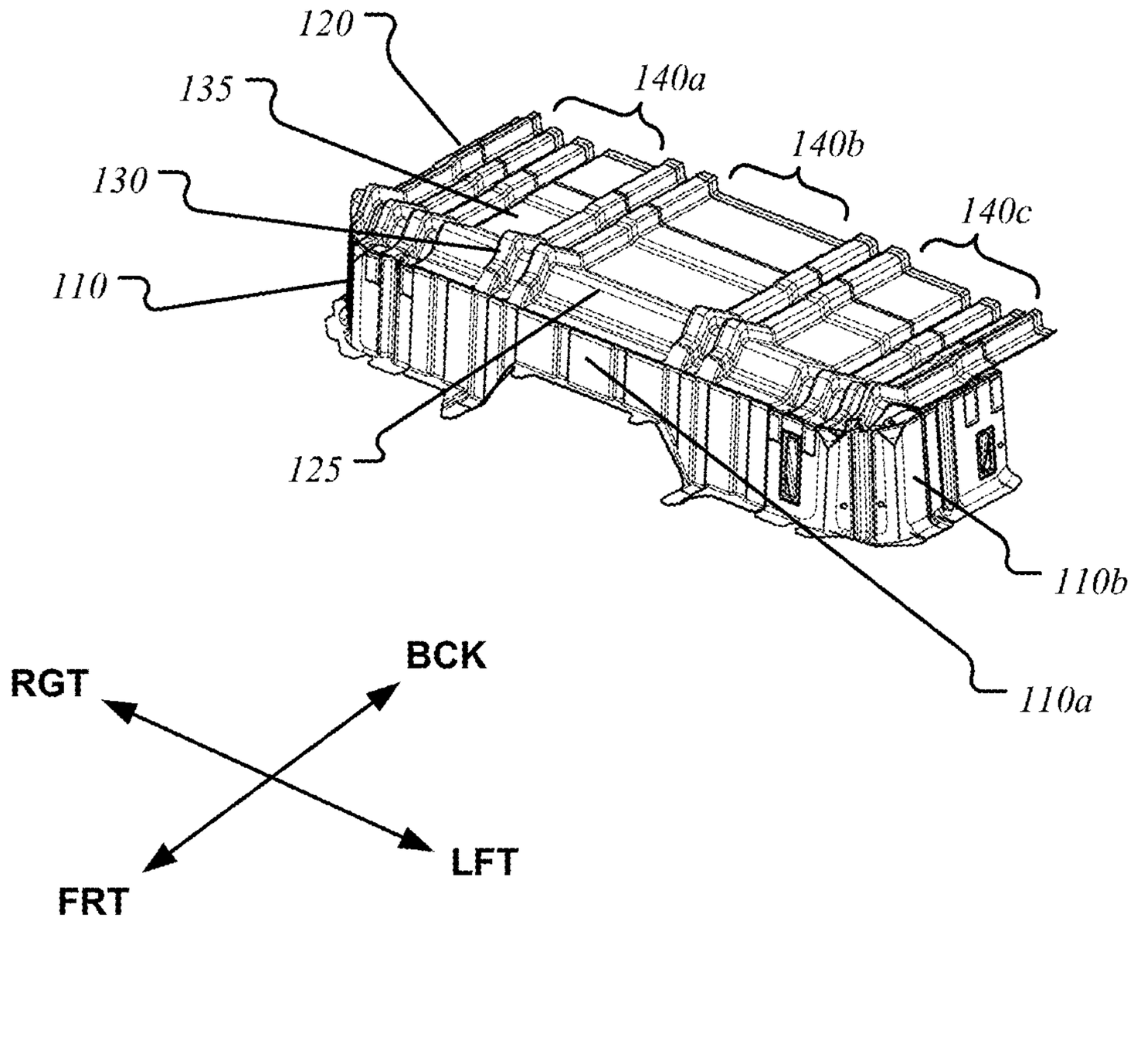


FIG. 3

FIG. 4A

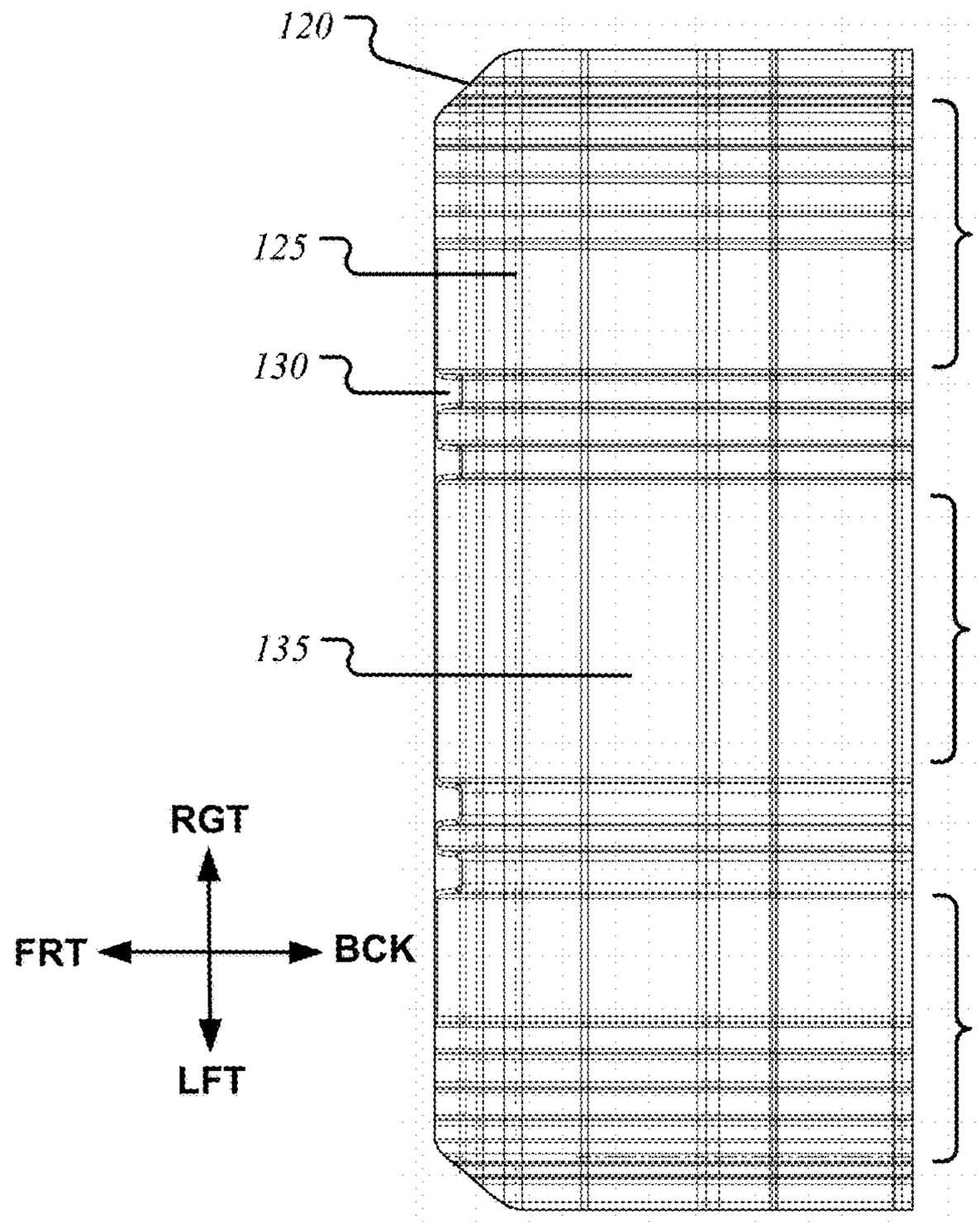
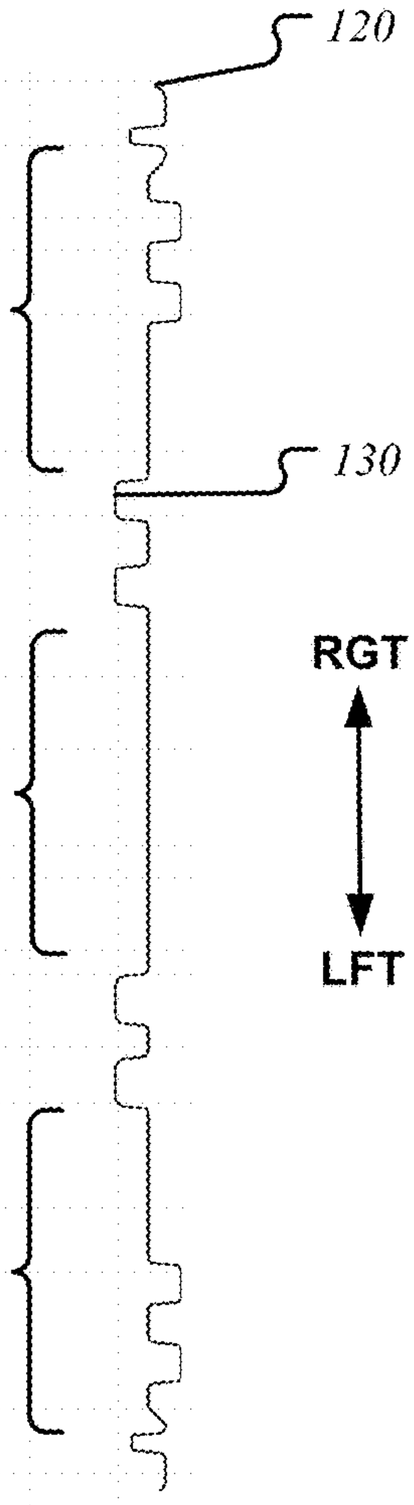


FIG. 4B



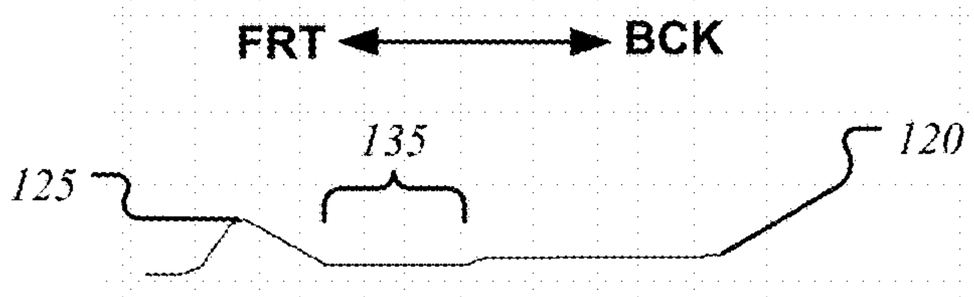


FIG. 4C

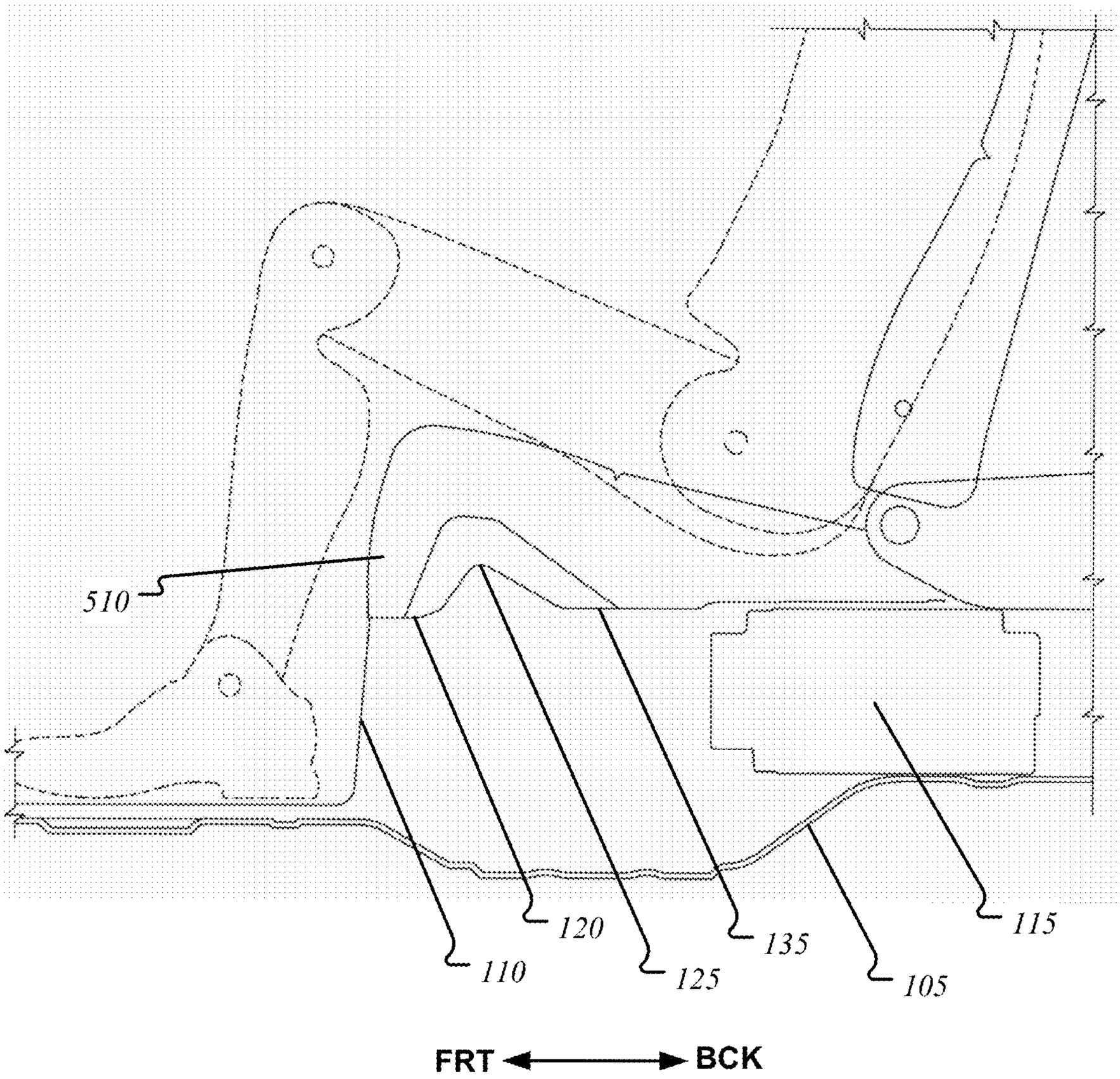


FIG. 5

PROTECTIVE SEAT LOAD FLOOR FOR HYBRID VEHICLES

FIELD OF THE DISCLOSURE

This specification relates generally to an anti-submarining feature incorporated into a protective seat load floor for automobiles.

BACKGROUND

The "background" description provided herein is for the purpose of generally presenting the context of the disclosure. Work of the presently named inventors, to the extent it is described in this background section, as well as aspects of the description which may not otherwise qualify as prior art at the time of filing, are neither expressly or impliedly admitted as prior art against the present invention.

During a frontal automobile collision or sudden braking event, rapid deceleration can cause occupants to undergo what is known as "submarining," or the tendency for occupants to slide partially underneath the portion of the seat belt running across the lap.

SUMMARY

To help prevent this phenomenon from occurring, an anti-submarining feature can be integrated into the automobile seat. Some features currently employed include a crossbar installed transverse to the seat frame inside or below the seat cushions. While this feature may help prevent a forward sliding motion when the occupant sinks into the seat and the bar pushes against the occupant's upper leg, the small cross-sectional area of the transverse crossbar means the force exerted on the occupant is high and concentrated.

In addition, considerable force is exerted downwards by the occupant during a frontal collision. In the event that components are stored below the occupant, for example a battery assembly, the seat must be able to support the occupant and withstand the added stresses during the frontal collision. Thus, a seat load floor with an integrated feature that prevents submarining and more evenly distributes forces on an occupant during a collision is needed.

The foregoing paragraphs have been provided by way of general introduction, and are not intended to limit the scope of the following claims. The described embodiments, together with further advantages, will be best understood by reference to the following detailed description taken in conjunction with the accompanying drawings.

According to various aspects of the disclosed subject matter, a vehicle seating apparatus is presented. The apparatus includes a structural tub and a protective seat load floor wherein the protective seat load floor includes an anti-submarining feature. The apparatus can also be disposed on top of the structural tub housing a battery for an electrified vehicle, wherein the seat load floor serves as the battery cover.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the disclosed embodiments and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1** is an isometric view of a vehicle that includes an upper body frame, an underbody, a structural tub, a battery, and a protective seat load floor where the protective seat load floor is not secured to the structural tub according to one or more aspects of the disclosed subject matter;

FIG. **2** is an isometricview of a vehicle that includes an upper body frame, an underbody, a structural tub, a battery, and a protective seat load floor where the protective seat load floor is secured to the structural tub according to one or more aspects of the disclosed subject matter;

FIG. **3** is an isometric view of a structural tub and a protective seat load floor where the protective seat load floor is secured to the structural tub according to one or more aspects of the disclosed subject matter;

FIG. **4**A is a top-down view of a protective seat load floor according to one or more aspects of the disclosed subject matter;

FIG. **4**B is a side-view cross-section of a protective seat load floor according to one or more aspects of the disclosed subject matter;

FIG. **4**C is a back-view cross-section of a protective seat load floor according to one or more aspects of the disclosed subject matter;

FIG. **5** is a side-view cross-section of a passenger sitting in a vehicle seating apparatus that includes an a structural tub, a battery, a seat cushion, and a protective seat load floor according to one or more aspects of the disclosed subject matter.

DETAILED DESCRIPTION

The description set forth below in connection with the appended drawings is intended as a description of various embodiments of the disclosed subject matter and is not necessarily intended to represent the only embodiment(s). In certain instances, the description includes specific details for the purpose of providing an understanding of the disclosed embodiment(s). However, it will be apparent to those skilled in the art that the disclosed embodiment(s) may be practiced without those specific details.

It is to be understood that terms such as "front," "back," "right," "left," "side," "top," and the like that may be used herein merely describe points of reference and do not necessarily limit embodiments of the present disclosure to any particular orientation or configuration.

The present disclosure relates to a feature that can decrease the likelihood of submarining during a frontal automobile collision by resisting a forward (i.e. towards the front) sliding motion of the occupant's upper leg and pelvis and therefore securing the occupant in a more upright position firmly in a vehicle seat. Moreover, the feature is integrated into a seat load floor with a large area, allowing forces felt by the occupant during a collision to be spread evenly over the entire surface of the seat load floor. The seat load floor also serves a dual purpose as the top protective housing for the battery, thereby saving time and resources in making a separate cover. In addition, the anti-submarining feature can be utilized in combination with other common safety features for greater effect, such as seat belt pretensioners and/or seat belt force-limiters.

A typical vehicle body including an upper body frame **100** and an underbody **105** is illustrated in FIGS. **1-3**, along with a legend to identify vehicle orientation in terms of the front (FRT), back (BCK), left (LFT), and right (RGT) directions. In an exemplary embodiment, a plurality of interior structural elements can be attached to the underbody **105**, such as a structural tub **110** for a rear seat. The structural tub **110** can

include a vertical front wall **110***a* running transverse to the vehicle body (i.e. left to right) and at least one vertical side wall **110***b*, preferably two vertical side walls **110***b*, disposed on right-most and left-most ends of the front wall **110***a*. The structural tub **110** can include a plurality of holes machined at predetermined locations in order to allow fastening of other parts to the top of the structural tub **110**. Non-limiting examples of an appropriate material for the seat floor **120** are high strength steel, aluminum, carbon fiber epoxy composite, resin, and glass reinforced resin.

The structural tub **110** can also house a high voltage battery assembly **115** (herein referred to as the battery **115**) that can be attached to the underbody **105**. The battery **115** can be disposed towards the back of the structural tub **110** and adjacent to the trunk space of the vehicle (not shown). The battery **115** can include a plurality of rechargeable cells, for example lithium ion cells, that power the vehicle. Additionally, a plurality of other battery components **115***a* used for normal battery **115** operations can be housed in the structural tub **110** and disposed in front of the battery **115**. The battery components **115***a* can include, for example, high voltage wires.

In an exemplary embodiment, the battery **115** can have a height such that the top of the battery **115** is level with or nearly close to being level with the top of the structural tub **110**. This can allow a relatively flat structure to rest on top the structural tub **110** and battery **115**, such as a protective seat load floor **120** (herein referred to as seat floor **120**) as illustrated above the aforementioned components in FIGS. **1-3**. The seat floor **120** can therefore also act as both the protective cover for the battery **115** and the support structure for occupants.

The seat floor **120** can be of a hexagonal shape with a first long back edge and a second long front-facing edge having two corners that can be rounded or cut at an angle, for example a 45 degree angle, in order to closely match the shape of the structural tub **110** below. The seat floor **120** can be fabricated using a stamping method, such as metal stamping, wherein multiple features are incorporated into a mold and transferred during the stamping process. This method, in turn, can reduce fabrication steps, use less material, and reduce material waste. The seat floor **120** can be installed by securing it to the structural tub **110** using, for example, bolts, screws, or clips. The design, material choice, and manufacturing method for the seat floor **120** can allow the seat floor **120** to be lightweight, a single piece, and facile to install by humans or robots compared to, for example, a metal structural bracket apparatus with multiple pieces that is required to secure the battery **115**.

A non-limiting example of an exemplary material for the seat floor **120** is SPC980 steel. The width of the seat floor **120** can be, for example, 800 mm to 1500 mm, or preferably, 1288.5 mm. The maximum profile height of the seat floor **120** can be, for example, 40 mm to 100 mm, or preferably, 61 mm. The thickness of the seat floor **120** material can be, for example, 0.5 mm to 10 mm, or preferably, 1 mm.

The seat floor **120** can include an integrated anti-submarining feature **125** laterally spanning (i.e. from left to right) the seat floor **120** and disposed towards the front-facing long edge of the seat floor **120**. Integrating the anti-submarining feature into the seat floor **120** eliminates the need for a separate anti-submarining feature, for example an anti-submarining bar as part of a metal structural bracket apparatus, and thus reduces material requirements and overall structure mass. FIG. **4**A illustrates a top-down view of the seat floor **120** and FIG. **4**B illustrates a side-view cross-section from the left-hand side. As seen in FIG. **4**B, the anti-submarining feature **125** can be a raised shape, for example a triangular or curved wedge, which resists back-to-front sliding movement. The height of the anti-submarining feature **125** can be, for example, 10 mm to 100 mm, or preferably, 60 mm. During a frontal collision, the upper leg and pelvis of the occupant can slide forward along the seat floor **120** and encounter the anti-submarining feature **125**, where the upper leg can then press against the anti-submarining feature **125**, preventing it from sliding forward further. If the occupant is wearing a seat belt, this can prevent the occupant from sliding under the seat belt and can keep the ventral portion of the seat belt more centrally disposed above the occupant's pelvis. Moreover, the seat floor **120** and anti-submarining feature **125** can provide a greater surface area, for example compared to a thin anti-submarining bar, over which the occupant's downward forces (due to rapid deceleration) are distributed during a frontal collision.

The seat floor **120** can also include one or more structures, for example one or more corrugated features **130** (herein referred to as corrugated features **130**) and recessed zone **135** that increase the seat floor **120** strength. The corrugated features **130** can run in a front-to-back direction along the seat floor **120**, intersect the anti-submarining feature **125**, and be raised above or depressed below a plane of the seat floor **120** (where unimpeded by the battery **115**). The corrugated features **130** can follow the contours of the seat floor **120** while maintaining its shape relative to the seat floor **120**. As illustrated in FIGS. **1-4**, there can be a first set of depressed corrugated features **130** along the right side of a first outboard seat **140***a*, followed by a set of raised corrugated features **130** that separate the first outboard seat **140***a* and an inboard seat **140***b*, followed by another set of raised corrugated features **130** that separate the inboard seat **140***b* and a second outboard seat **140***c*, and then a final set of depressed corrugated features **130** along the left side of the second outboard seat **140***c*. Together, the corrugated features **130** and the recessed zone **135** importantly serve to protect the underlying battery **115** from downward forces exerted by the occupant in a frontal collision.

FIG. **4**C illustrates a back-view cross-section of FIG. **4**A. As seen in FIG. **4**C, the corrugated features **130** can adopt myriad pre-determined cross-sectional shapes, for example triangular, rectangular, or curved, while still providing increased strength to the seat floor **120**. The height of the corrugated features **130** can be, for example, 10 mm to 60 mm, or preferably, 31 mm.

The recessed zone **135** can be a laterally spanning section of the seat floor **120** that is disposed between the anti-submarining feature **125** and the second long edge, and is depressed below the plane of the seat floor. In a front-to-back direction, the recessed zone **135** can extend from behind the anti-submarining feature **125** to the battery **115**, where it elevates to a height where the remainder of the seat floor **120** can be disposed such that it covers the battery **115**. The recessed zone **135** can be flat or adopt an upward opening concave shape (when viewed from the side cross-sectional profile) in order to maximize occupant comfort or increase the effectiveness of the anti-submarining feature **125**. The depression depth of the recessed zone **135** can be, for example in the case of a flat profile, 0.5 to 50 mm, or preferably, 10 mm.

The corrugated features **130** can also serve as a location index during the installation of a seat cushion, as illustrated in FIGS. **1-4**. Both the raised and depressed corrugated features **130** provide easily identifiable features that can be correlated to corresponding features on the underside of the

seat cushion **510** in FIG. **5**. This can allow for faster and more consistent installation of the seat cushion **510** by an operator during manufacturing.

The corrugated features **130** and recessed zone **135** can also improve passenger comfort when the seat cushion **510** is installed on top of the seat floor **115**. The depressed sections of corrugated features **130** and recessed zone **135** can allow for more overall seat cushion **510** material to be used to fill the vacancies and thus improve passenger comfort.

According to an alternative embodiment, the vehicle can be of a smaller size such that the rear seat is narrower (and thereby the rear seat tub **110**) and only allows for a maximum of two passengers to sit on the seat floor **120**. In this embodiment, the seat floor **120** can include a first outboard seat **140***a* and a second outboard seat **140***c* and not include an inboard seat **140***b*. The seat floor **120** can include the lateral anti-submarining feature **125** close to its long front-facing edge, as well as corrugated features **130** and recessed zone **135**. The one or more depressed corrugated features **130** can be disposed along the left and right edges of the seat floor **120** and the one or more raised corrugated features **130** can be disposed in the middle of the seat floor **120** such that the one or more raised corrugated features **130** separate the first and second outboard seats **140***a*, **140***c*.

Advantages according to the prior exemplary embodiment are retained and summarized again. The advantages include facile fabrication and installation of the lightweight seat floor **120** via a stamping process, decreased forward sliding motion, and decreased pressure on the upper leg and pelvis during a frontal collision via the anti-submarining feature **125** and seat floor **120**, location indexing for the seat cushion **510** during manufacturing via the corrugated features **130**, and increased strength and improved passenger comfort via both the corrugated features **130** and recessed zone **135**.

While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the present disclosures. Indeed, the novel methods, apparatuses and systems described herein can be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the methods, apparatuses and systems described herein can be made without departing from the spirit of the present disclosure. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the present disclosure.

What is claimed is:

1. A vehicle seating component, comprising:

a seat load floor including a first edge and a second edge, wherein the first edge is disposed towards a front end of a vehicle and the second edge is disposed towards a back end of the vehicle; and

a raised portion of the seat load floor adjacent to and along the first edge and configured to impede a movement of an object towards the front end of the vehicle.

2. The vehicle seating component of claim **1**, further comprising:

one or more corrugated features intersecting the raised portion and disposed between the first edge and the second edge, wherein the one or more corrugated features are raised above or depressed below a plane of the seat load floor.

3. The vehicle seating component of claim **2**, wherein the one or more corrugated features follow the contour of the seat load floor while maintaining a shape of the one or more corrugated features relative to the seat load floor.

4. The vehicle seating component of claim **2**, wherein the component includes a first set of two depressed corrugated features along a first outer edge of a first outboard seat, a second set of two raised corrugated features separating the first outboard seat and an inboard seat, a third set of two raised corrugated features separating the inboard seat and a second outboard seat, and a fourth set of two depressed corrugated features along a second outer edge of the second outboard seat.

5. The vehicle seating component of claim **1**, further comprising:

a recessed zone that is disposed between the raised portion and the second edge and is depressed below a plane of the seat load floor.

6. The vehicle seating component of claim **2**, further comprising:

a recessed zone that is disposed between the raised portion and the second edge and is depressed below a plane of the seat load floor.

7. The vehicle seating component of claim **1**, wherein a material of the component includes at least one of high strength steel, aluminum, carbon fiber epoxy composite, resin, and glass reinforced resin.

8. A vehicle seating apparatus, comprising:

a structural tub including a vertical wall, a first side wall disposed on a first end of the vertical wall, and a second side wall disposed on a second opposite end of the vertical wall, wherein the structural tub is configured to secure a battery during vehicle movement and to support a structure secured to the top of the structural tub; and

a vehicle seating component including

a seat load floor including a first edge and a second edge, wherein the first edge is disposed towards a front end of a vehicle and the second edge is disposed towards a back end of the vehicle, and

a raised portion of the seat load floor adjacent to and along the first long edge and configured to impede a movement of an object towards the front end of the vehicle.

9. The vehicle seating apparatus of claim **8**, wherein the vehicle seating component includes

one or more corrugated features intersecting the raised portion and disposed between the first edge and the second edge, wherein the one or more corrugated features are raised above or depressed below a plane of the seat load floor.

10. The vehicle seating apparatus of claim **8**, wherein the vehicle seating component includes

a recessed zone that is disposed between the raised portion and the second edge and is depressed below a plane of the seat load floor.

11. The vehicle seating apparatus of claim **9**, wherein the vehicle seating component includes

a recessed zone disposed between the raised portion and the second edge and is depressed below a plane of the seat load floor.

12. The vehicle seating apparatus of claim **8**, wherein a material of the vehicle seating component includes at least one of high strength steel, aluminum, carbon fiber epoxy composite, resin, and glass reinforced resin.

13. The vehicle seating apparatus of claim **8**, wherein the vehicle seating component includes

a first set of two depressed corrugated features along a first outer edge of a first outboard seat,

a second set of two raised corrugated features separating the first outboard seat and an inboard seat,

a third set of two raised corrugated features separating the inboard seat and a second outboard seat, and

a fourth set of two depressed corrugated features along a second outer edge of the second outboard seat.

14. The vehicle seating apparatus of claim **8**, wherein the vehicle seating component is configured to support a downward force exerted by an object disposed above the vehicle seating component during a vehicle collision or rapid deceleration.

15. The vehicle seating apparatus of claim **8**, wherein the vehicle seating component is configured to be implemented in a vehicle in conjunction with a safety belt.

16. The vehicle seating apparatus of claim **8**, wherein the vehicle seating component is fabricated using a stamping method.

17. The vehicle seating apparatus of claim **8**, wherein the vehicle seating component is fabricated using a molding process.

18. The vehicle seating apparatus of claim **8**, wherein the vehicle seating component is secured to the structural tub using bolts, screws, or clips.

19. The vehicle seating apparatus of claim **8**, wherein the vehicle seating component includes a first outboard seat, a second outboard seat, and does not include an inboard seat.

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